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THE RESULTANT CORRECTION CYLINDER OF COMBINED CORNEAL ASTIGMATISM AT OBLIQUE AXIS AND PHYSIOLOGICAL ASTIGMATIC ALLOWANCE*

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Every practitioner has had the experience that frequently the axis of the correction cylinder as found retinoscopically and subjectively does not coincide with the axis of the cylinder indicated by the Ophthalmometer. This phenomenon did particularly appear in cases with ophthalmometric cylinders at oblique axis. The causes of this occurrence are various. They may be purely physiological, such as torsion of the eye ball, obliquity of the lens, obliquity of the lenticular astigmatism, or purely psychological such as perpendicular interpretation influencing the subjective test. These causes, however, can be neither diagnosed nor separated by our present day refraction. The predominant cause for a difference between ophthalmometer and final correction cylinder axis may be termed physiologic-optical in character and can be taken into, at least qualitative, consideration.

Since November, 1929, the author's idea and calculations as to the influence of the spherical component upon the cylinder power in cases of a sphero-cylinderical lens have been made public and in April, 1930, the *"American Journal of Optometry"* published an article pertaining to this idea.

As this article particularly tends to disprove the so-called Javal's rule (so-called, because the author could not find any such rule in Javal's writings) and because this article also deals with one part of said Javal's rule, it may be well to restate this rule as it is or rather was taught throughout the country. Javal's rule may be cited in two parts, namely:

1. Read Ophthalmometer as to minus cylinder values. On account of distance from correction lens to anterior surface of cornea increase the amount found with the ophthalmometer by 25 per cent.

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This part, the author disapproved in the article of April, 1930, appearing in the "*American Journal of Optometry.*" The mistake made in this part of the rule is that it does not take into consideration the influence of the spherical component of a compound lens. It has been shown that a hyperopic correction diminishes the correction cylinder while a myopic correction increases it. Clinical evidence gathered at the Pennsylvania State College of Optometry has sustained these optical calculations.

2. Concerning the allowance for physiological astigmatism, the rule says, "Add —.25 (or —.50) if the corneal astigmatism (minus cyl.) is against the rule (axis at or near 90°) and +.25 (+.50) if the corneal astigmatism (minus cyl.) is with the rule (axis at or near 180°).

"If the corneal astigmatism is at 135° or 45° (or near) no allowance to offset the physiological astigmatism is to be made."

It is to this second part of this rule that the author has to take exception in this article. The question may very well be raised, "Does the fact that the ophthalmometer reveals the corneal astigmatic axis to be at 45° or 135° wipe out the physiological astigmatism so that it has no influence upon the correction cylinder?" Naturally this can not be the case. The physiological astigmatism, whatever his cause, is to be considered as something permanent at least for a given person at a given age. This physiological astigmatism increases with age (Helmholtz, Sheard, etc.) and is approximately +.25 ax 90° (up to 30 years), +.50 ax 90° (from 30 to 60 years), and +.75 ax 90° (from 60 years on up), making the

	Amount	*Age*
Allowance for physiological astigmatism	—.25 ax 90°	up to 30 years
Allowance for physiological astigmatism	—.50 ax 90°	30 to 60 years
Allowance for physiological astigmatism	—.75 ax 90°	above 60 yrs.

With this allowance for the physiologic astigmatism the corneal astigmatism (Ophthalmometer) combines exactly as two crossed cylinders would combine. As long as the axes of these two crossed cylinders enclose an angle of 90° the axis of the resultant cylinder will coincide with the axis of the dominant component. For this condition the first sentence of the second part of Javal's rule holds true. In order to make the point, it may not be amiss to quote a few examples:

1. Patient 20 years. Ophthalmometer reading	—1.00 ax 180°
Allowance for physiological astigmatism	— .25 ax 90°
Resultant cyl.	— .75 ax 180°
2. Patient 55 years. Ophthalmometer reading	— .25 ax 180°
Allowance for physiological astigmatism	— .50 ax 90°
Resultant cyl.	— .25 ax 90°

3. Patient 48 years. Ophthalmometer reading . . . . . —1.50 ax 90°
Allowance for physiological astigmatism . . . . . — .50 ax 90°

Resultant cyl. . . . . —2.00 ax 90°

In all these three examples, the influence of the spherical element upon the cylindrical element of a compound prescription lens, is disregarded.

Supposing the ophthalmometer reading is —.50 ax 135° (or 45°) and the patient's age be 50 years, the second part of Javal's rule (as taught) says for this case that the physiological astigmatism has no influence upon the final correction cylinder. The actual true concept, however, is that we deal now with two crossed cylinders, enclosing an angle of 45°, the corneal astigmatism (—.50 ax 135°) and the allowance for the physiologic astigmatism (—.50 ax 90°). This combina-

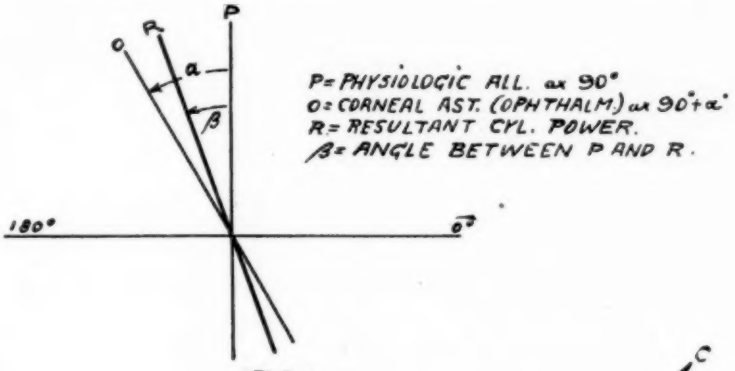


FIG. 1.

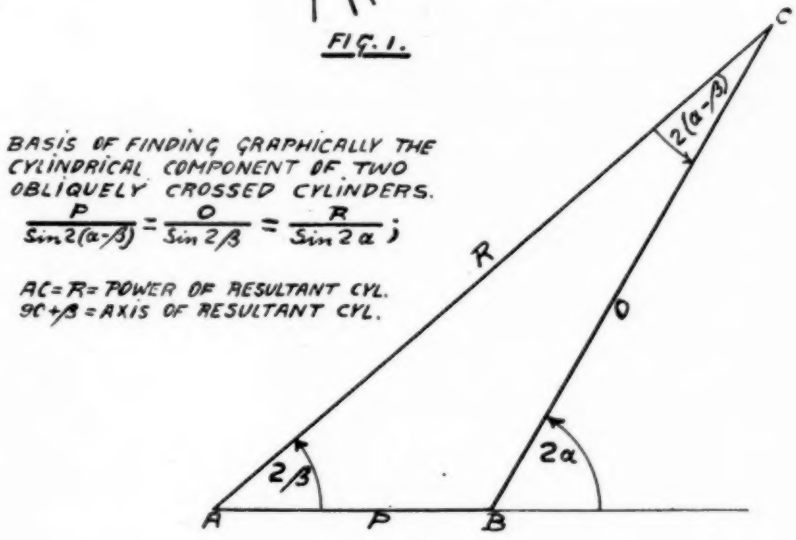


FIG. 2.

tion reads —.50 ax 135° ⌒ —.50 ax 90° and the resultant cylinder is —.71 ax 112°. The influence of the allowance for the physiologic astigmatism upon a correal astigmatism at axis 135° (or 45°) is therefore far from being "nil" and is, on the contrary, quite noticeable. In the chosen example, it increases the resultant correction cylinder by about —.25 D and turns its axis through 23°. This increase in power and the turning of the axis of the resultant cylinder is naturally evident in all cases of two obliquely crossed cylinders.

In the accompanying tables and graphs, the author has set forth the power and axis of the resultant cylinders by combining various Ophthalmometer findings with the three principal allowances for physiologic astigmatism (—.25, —.50, —.75 ax 90°). The results were arrived at by graphical method as shown in Figure 1 and Figure 2. Table I shows the results giving the dioptric value of the resultant cylinder and its axis. F.i. The Ophthalmometer finding for a patient 40 years of age (physiological astigmatic allowance —.50 ax 90°) be —1.00 ax 30°. The resulting cylinder due to these two components would then be —.87 ax 45°. The graphs on Table II and III simply show by graphical method the results of Table I. The lower part of each graph shows in diopters the power of the resultant cylinder while the upper part shows in degrees the axis of the resultant cylinder.

Example. Ophthalmometer reading	—2.00 ax 150°
Age of patient, 65 years. Phys. All.	— .75 ax 90°
Resultant cyl. abt.	—1.75 ax 140°

The author has tried, but has failed, to bring these curves under the control of a simple thumb rule. In general, we may divide these diagrams into two main groups, namely:

1. Cases in which the Ophthalmometer findings are equal to, or smaller than, the physiological allowance, these combinations are:

Ophthalmometer	*Physiological Allowance*
—.25 ax	—.25 ax 90°
—.25 ax	—.50 ax 90°
—.25 ax	—.75 ax 90°
—.50 ax	—.50 ax 90°
—.50 ax	—.75 ax 90°
—.75 ax	—.75 ax 90°

The latter one is not shown but the axis graph is similar to the one of cases —.25 ax ⌒ —.25 ax 90° and —.50 ax ⌒ —.50 ax 90° t. i. a straight line running from 45° to 135°.

2. Cases where the Ophthalmometer findings are larger than the physiological allowances. The shown diagrams for these cases are

TABLE I.

RESULTANT CYLINDER OF OPHTH. CYL ⊂ PHYS. ALL'NCE.

OPHTHALMOMETER R'D'G -.25 ax.

OPH. AX.	PA-.25 ax 90°	PA-.50 ax 90°	PA-.75 ax 90°
0°	0 ax 45°	.25 ax 90°	.50 ax 90°
15°	.13 ax 52°	.30 ax 77°	.55 ax 83°
30°	.25 ax 60°	.43 ax 73°	.67 ax 81°
45°	.36 ax 68°	.56 ax 76°	.79 ax 81°
60°	.44 ax 75°	.67 ax 80°	.90 ax 83°
75°	.48 ax 83°	.73 ax 85°	.97 ax 86°
90°	.50 ax 90°	.75 ax 90°	1.00 ax 90°
105°	.48 ax 97°	.73 ax 95°	.97 ax 94°
120°	.44 ax 105°	.67 ax 100°	.90 ax 97°
135°	.36 ax 112°	.56 ax 106°	.79 ax 99°
150°	.25 ax 120°	.46 ax 107°	.67 ax 99°
165°	.13 ax 128°	.30 ax 103°	.55 ax 97°
180°	0 ax 135°	.25 ax 90°	.50 ax 90°

OPHTHALMOMETER R'D'G -.50 axis

OPH. AX.	PA-.25 ax 90°	PA-.50 ax 90°	PA-.75 ax 90°
0°	.25 ax 0°	0 ax 45°	.25 ax 90°
15°	.31 ax 27°	.26 ax 53°	.41 ax 71°
30°	.44 ax 45°	.50 ax 60°	.65 ax 70°
45°	.58 ax 58°	.71 ax 68°	.90 ax 73°
60°	.67 ax 70°	.87 ax 75°	1.05 ax 79°
75°	.72 ax 80°	.96 ax 83°	1.21 ax 84°
90°	.75 ax 90°	1.00 ax 90°	1.25 ax 90°
105°	.72 ax 100°	.96 ax 97°	1.21 ax 96°
120°	.67 ax 110°	.87 ax 105°	1.05 ax 101°
135°	.58 ax 122°	.71 ax 112°	.90 ax 107°
150°	.44 ax 135°	.50 ax 120°	.65 ax 110°
165°	.31 ax 153°	.26 ax 127	.41 ax 109°
180°	.25 ax 180°	0 ax 135°	.25 ax 90°

OPHTHALMOMETER R'D'G. -1.00 ax.

OPH. AX.	P.A.-.25 ax 90°	P.A.-.50 ax 90°	P.A.-.75 ax 90°
0°	.75 ax 0°	.50 ax 0°	.25 ax 0°
15°	.79 ax 20°	.63 ax 27°	.52 ax 39°
30°	.90 ax 37°	.87 ax 45°	.86 ax 54°
45°	1.03 ax 52°	1.11 ax 58°	1.25 ax 63°
60°	1.14 ax 66°	1.32 ax 70°	1.47 ax 73°
75°	1.22 ax 78°	1.46 ax 80°	1.67 ax 82°
90°	1.25 ax 90°	1.50 ax 90°	1.75 ax 90°
105°	1.22 ax 102°	1.46 ax 100°	1.69 ax 98°
120°	1.14 ax 114°	1.32 ax 110°	1.47 ax 107°
135°	1.03 ax 128°	1.11 ax 122°	1.25 ax 117°
150°	.93 ax 143°	.87 ax 135°	.86 ax 126°
165°	.79 ax 160°	.63 ax 153°	.52 ax 141°
180°	.75 ax 180°	.50 ax 180°	.25 ax 180°

OPHTHALMOMETER R'D'G.-1.50 axis.

OPH AX.	P.A.-.25 ax 90°	P.A-.50 ax 90°	PA-.75 ax 90°
0°	1.25 ax 0°	1.00 ax 0°	.75 ax 0°
15°	1.29 ax 14°	1.10 ax 22°	.93 ax 27°
30°	1.39 ax 35°	1.33 ax 40°	1.26 ax 45°
45°	1.52 ax 50°	1.58 ax 54°	1.67 ax 58°
60°	1.64 ax 64°	1.81 ax 67°	1.93 ax 70
75°	1.72 ax 77°	1.95 ax 79°	2.18 ax 80
90°	1.75 ax 90°	2.00 ax 90°	2.25 ax 90°
105°	1.72 ax 103°	1.95 ax 101°	2.18 ax 100°
120°	1.64 ax 116°	1.81 ax 113°	1.93 ax 110°
135°	1.52 ax 130°	1.58 ax 126°	1.67 ax 122°
150°	1.39 ax 145°	1.33 ax 140°	1.26 ax 135°
165°	1.29 ax 162°	1.10 ax 158°	.93 ax 153°
180°	1.25 ax 180°	1.00 ax 180°	.75 ax 180°

OPHTHALMOMETER R'D'G -2.00 axis

OPH. AX.	PA-.25 ax 90°	PA-.50 ax 90°	PA-.75 ax 90°
0°	1.75 ax 0°	1.50 ax 0°	1.25 ax 0°
15°	1.79 ax 17°	1.60 ax 20°	1.40 ax 23°
30°	1.89 ax 33°	1.80 ax 37°	1.70 ax 41
45°	2.02 ax 49°	2.06 ax 52°	2.13 ax 55°
60°	2.13 ax 63°	2.19 ax 66°	2.41 ax 69°
75°	2.22 ax 77°	2.46 ax 78°	2.67 ax 79°
90°	2.25 ax 90°	2.50 ax 90°	2.75 ax 90°
105°	2.22 ax 103°	2.44 ax 102°	2.67 ax 101°
120°	2.15 ax 117°	2.29 ax 116°	2.41 ax 112°
135°	2.02 ax 131°	2.06 ax 128°	2.13 ax 125°
150°	1.89 ax 147°	1.80 ax 143°	1.70 ax 139°
165°	1.79 ax 163°	1.60 ax 160°	1.40 ax 157°
180°	1.75 ax 180°	1.50 ax 180°	1.25 ax 180°

OPHTHALMOMETER R'D'G -2.50 axis

OPH. AX.	PA-.25 ax 90°	PA-.50 ax 90°	PA-.75 ax 90°
0°	2.25 ax 0°	2.00 ax 0°	1.75 ax 0°
15°	2.28 ax 17°	2.09 ax 19°	1.88 ax 21°
30°	2.38 ax 32°	2.29 ax 36°	2.17 ax 39°
45°	2.51 ax 48°	2.54 ax 51°	2.60 ax 53°
60°	2.63 ax 63°	2.78 ax 65°	2.89 ax 67°
75°	2.72 ax 76°	2.94 ax 77°	3.16 ax 77°
90°	2.75 ax 90°	3.00 ax 90°	3.25 ax 90°
105°	2.72 ax 104°	2.94 ax 103°	3.16 ax 103°
120°	2.63 ax 117°	2.78 ax 115°	2.89 ax 113°
135°	2.51 ax 132°	2.54 ax 129°	2.60 ax 127°
150°	2.38 ax 148°	2.29 ax 144°	2.17 ax 141°
165°	2.28 ax 163°	2.09 ax 161°	1.88 ax 159°
180°	2.25 ax 90°	2.00 ax 180°	1.75 ax 180°

TABLES GIVING CYLINDER POWER AND AXIS RESULTING FROM CORNEAL ASTIGMATISM OF VARYING AXIS AND POWER (-.25 TO -2.50 DIO.) AND PHYSIOLOGIC ALLOWANCE OF VARYING POWER (-.25 TO -.75 ax 90°). ALL CYLINDER POWERS ARE EXPRESSED IN MINUS QUANTITIES. THE VALUES IN THESE TABLES WERE DETERMINED BY GRAPHIC CONSTRUCTION.

TABLE II.

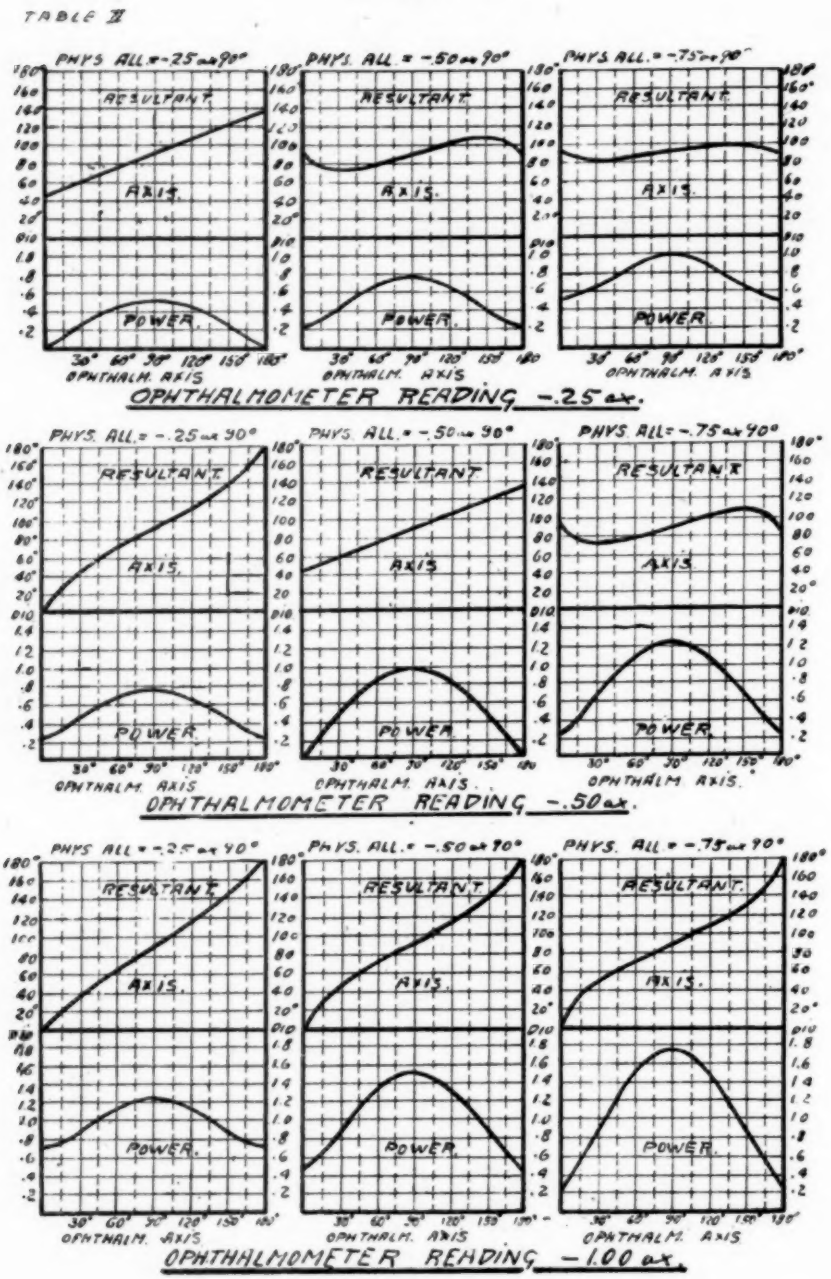
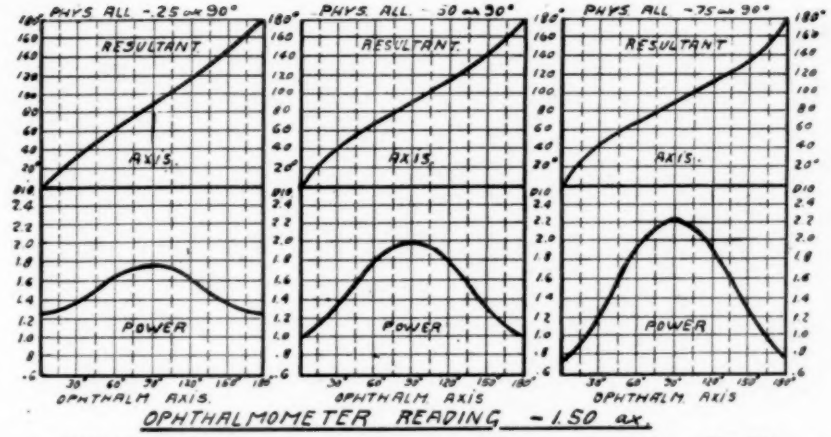
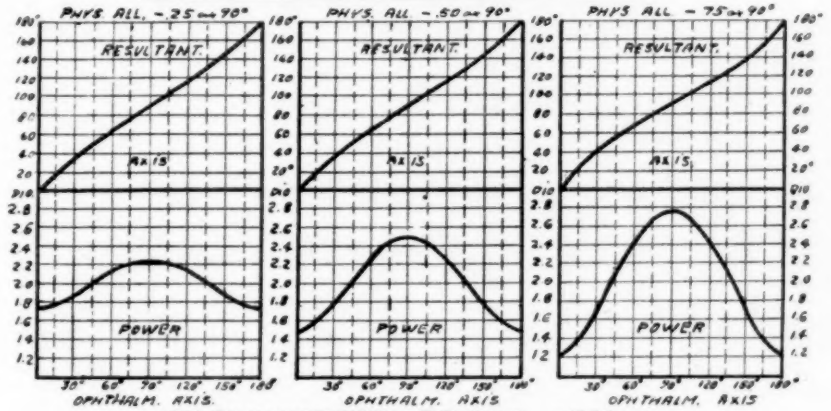


TABLE II
PHYS. ALL. = -.25 ax 90°
PHYS. ALL. = -.50 ax 90°
PHYS. ALL. = -.75 ax 90°
RESULTANT
AXIS.
POWER.
OPHTHALM. AXIS
OPHTHALMOMETER READING -.25 ax.
PHYS. ALL. = -.25 ax 90°
PHYS. ALL. = -.50 ax 90°
PHYS. ALL. = -.75 ax 90°
RESULTANT
AXIS
POWER.
OPHTHALM. AXIS.
OPHTHALMOMETER READING -.50 ax.
PHYS. ALL. = -.25 ax 90°
PHYS. ALL. = -.50 ax 90°
PHYS. ALL. = -.75 ax 90°
RESULTANT
AXIS.
POWER.
OPHTHALM. AXIS
OPHTHHALMOMETER READING -1.00 ax.

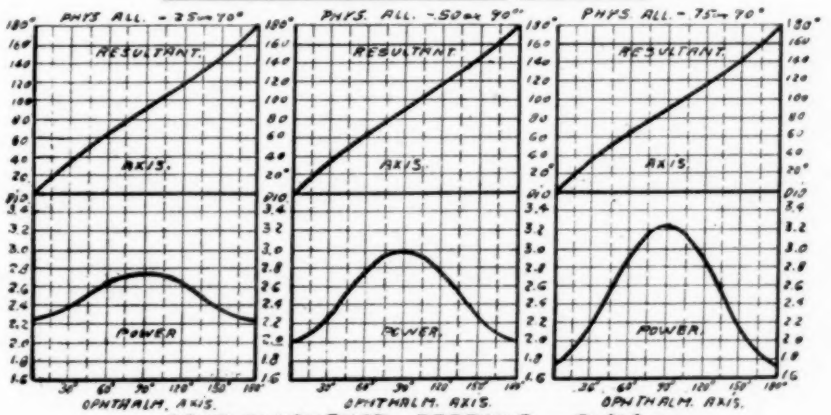
TABLE III.



OPHTHALMOMETER READING -1.50 ax.



OPHTHALMOMETER READING -2.00 ax.



OPHTHALMOMETER READING -2.50 ax.

Ophthalmometer	*Physiological Allowance*
— .50 ax	—.25 ax 90°
—1.00 ax	—.25 ax 90°
—1.00 ax	—.50 ax 90°
—1.00 ax	—.75 ax 90°
—1.50 ax	—.25 ax 90°
—1.50 ax	—.50 ax 90°
—1.50 ax	—.75 ax 90°
—2.00 ax	—.25 ax 90°
—2.00 ax	—.50 ax 90°
—2.00 ax	—.75 ax 90°
—2.50 ax	—.25 ax 90°
—2.50 ax	—.50 ax 90°
—2.50 ax	—.75 ax 90°

The less the difference between the dioptric powers of the components, the more will the axis of the resultant cylinder be influenced. The converse of this statement is equally true.

The greater the difference between the dioptric powers of the components, the less will the axis of the resultant cylinder be influenced.

Summary

This summary embraces this article as well as it does the one published in April, 1930. The author does not propose to make the determination of the resultant cylinder an object of mathematical optical procedure. He only wants to point out how the ophthalmometer reading is qualitatively influenced by the spherical ametropia and by the physiological allowance.

In general, it may be said that a hyperopic spherical correction combined with a minus corneal astigmatism tends to decrease the power of the minus correction cylinder.

A myopic spherical correction combined with a minus corneal astigmatism tends to increase the power of the minus correction cylinder.

When the ophthalmometer (always minus cylinders at or near 180°) reads "With the rule" the accepted cylinder is diminished by the physiological allowance of the patient's eye. When the Ophthalmometer (always minus cylinders at or near 90°) reads "Against the rule" the accepted cylinder is increased by the physiological allowance of the patient's age. When the Ophthalmometer reveals corneal astigmatism (always in minus cylinders) at an oblique axis, then the axis of the accepted correction cylinder will be located between this oblique axis and 90° (axis of minus cyl. of physiological allowance). The smaller the corneal astigmatism is relative to the physiological allowance, the more will the axis of the correction cylinder deviate from the axis of the corneal astigmatism.

The author thinks these two factors, vertex refraction and cross cylinder effect to be of primary influence upon the correction cylinder. The cylindrical changes due to accommodative lenticular astigmatism or to tilting of the crystalline lens he considers to be of secondary importance. The reason for this conviction is to be found in the low refractibility of the lens surfaces (about 1/5 of the outside corneal surface) and the thus necessary high changes in lens curvatures to effect a noticeable amount of lenticular astigmatism. Besides, when this lenticular astigmatism is due to sectional accommodation, it surely should be discouraged and not made permanent by correction.

Equally discouraged should be all false subjective astigmatic interpretations.

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LATENT EXOPHORIA
and
THE REDUCTION OF OCULAR REFRACTION
With Special Reference to Tetanus of Ciliary and Recti Muscles*
Part II.

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(Continued from the September issue)

Following are briefly summarized the stages through which the lateral adaptive quality of the visual neuro-muscular mechanism has passed in reaching its present culmination in man. In considering this presentation it should be again remembered that it is based upon the belief that evolutionists are correct in their assumption that animal life began as a single cell, that the living existence upon this planet today of the various stages of development commented upon tends very strongly to confirm the theory of evolution, and that there might be some truth in the idea that the embryonic life of man recapitulates in nine months his development over a period of hundreds of millions of years.

In the lowest form of animal life—single-cell—there are no eyes as we are now considering them, although there seems to be some power of heliotropic response extending apparently over the entire cell.

In later forms this function is concentrated in more highly developed sensitive "eye spots," leading ultimately to the formation of actual eyes. These are often quite numerous and scattered widely over the body.

In still higher stages, such as fish, they are commonly reduced to two, one on each side of the head. The visual axes in these naturally are directed away from each other, tending to approach 180°.

Owing to its vertebral and rib structure, the fish may be considered to be the true aquatic ancestor of man, and therefore we will assume that in so placing the fishes' eyes, Nature established a basic patent upon which gradual improvements have been made.

Passing over the countless millions of years during which some aquatic creatures emerged from the water and became tree-climbing, furred and warm blooded animals, we come to what some consider to be the present day representative of the particular group from which

*Submitted for publication August 16, 1933.

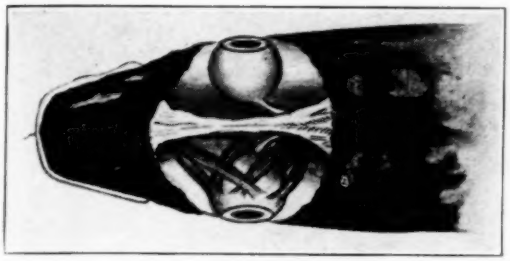


Figure 2.
Extrinsic muscles of the Cod Fish.
(Stevens. Motor Apparatus of the Eyes.)

man eventually emerged—the Tarsier of Borneo, a monkey so small it may be held in the hand. In this animal the visual axes are almost, if not quite, parallel; at any rate, the desirability of some form of stereoscopic effect is evidenced in the Tarsier's ability to turn his head

Figure 3.
Tarsier.
(G. Elliott Smith.
Evolution of Man.)

completely around so as to derive the full effect of binocular vision, whether single or not.

From this point we pass upward through the lower examples of progressive adaptation and closer approximation to the visual system of man as exemplified in the marmoset, macaque, gibbon and chimpanzee, the latter of which apparently most closely approximates man, although there is some rivalry for the position with the gorilla and orang.

The increasing dependence of the animal upon the vision and the growing importance of this function is evidenced in several ways. One consists of the progressive increase in the visual areas in the brain and the concomitant decrease in the olfactory area—lower animals depend more upon the sense of smell than upon vision.

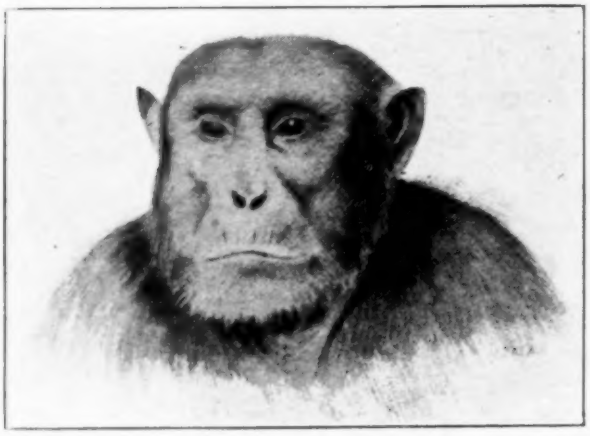
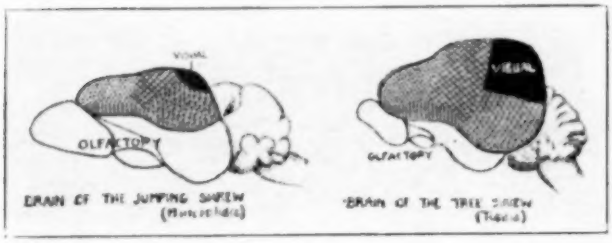


Figure 4. Chimpanzee.
(Gregory. Our Face from Fish to Man.)



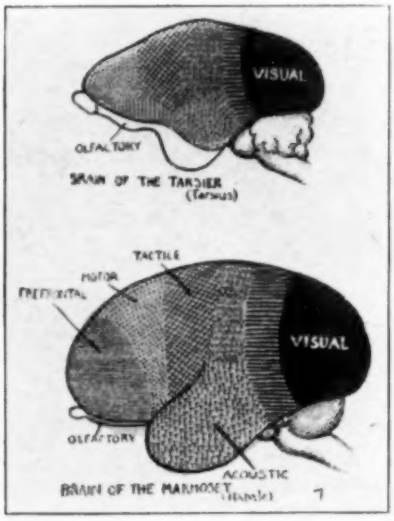


Figure 5. (Above) Illustrating comparative size of visual and olfactory areas in ground shrew and tree shrew. Naturally, the animal which lives in trees requires better visual apparatus than the ground animal. (G. Elliott Smith. Evolution of Man.)

Figure 6. (At left) Illustrating comparative size of visual and olfactory areas in Tarsier and Marmoset. Note ascending dominancy of visual areas and decline of olfactory areas. (G. Elliott Smith. Evolution of Man.)

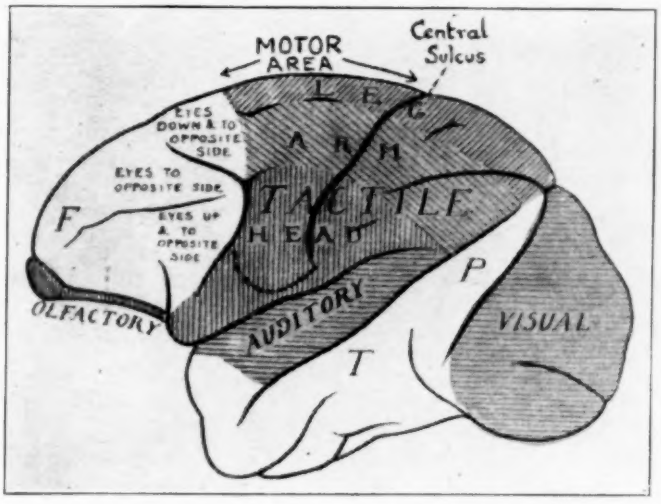


Figure 7. Diagram of the lateral aspect of the left cerebral hemisphere of the Macque. (G. Elliott Smith. Evolution of Man.)

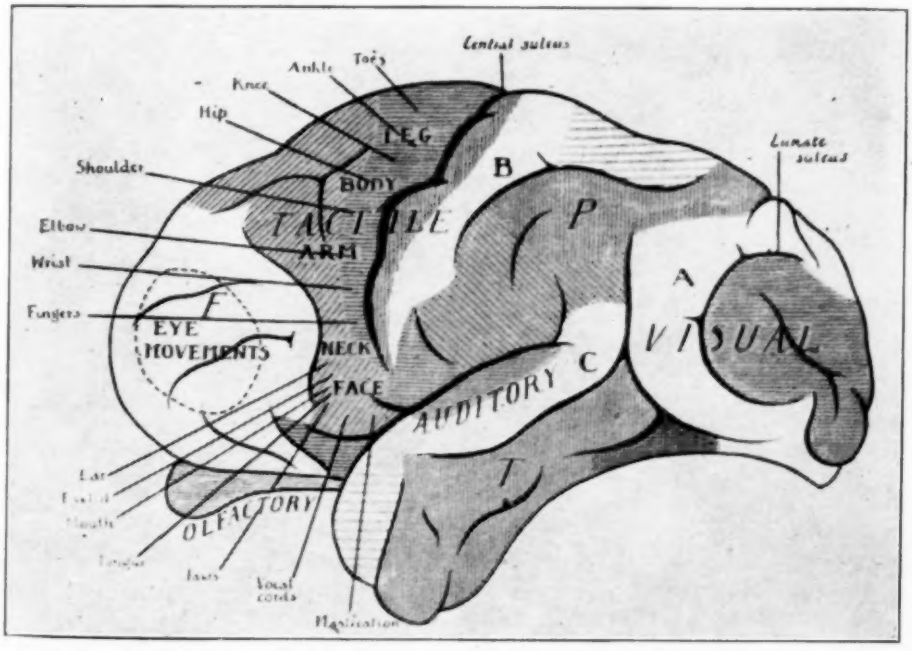


Figure 8. Diagram of the lateral aspect of the left cerebral hemisphere of the Gorilla. (G. Elliott Smith. Evolution of Man.)

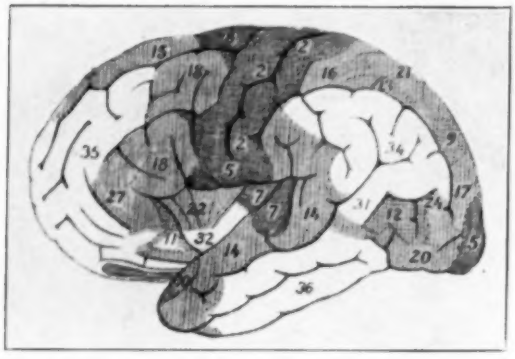
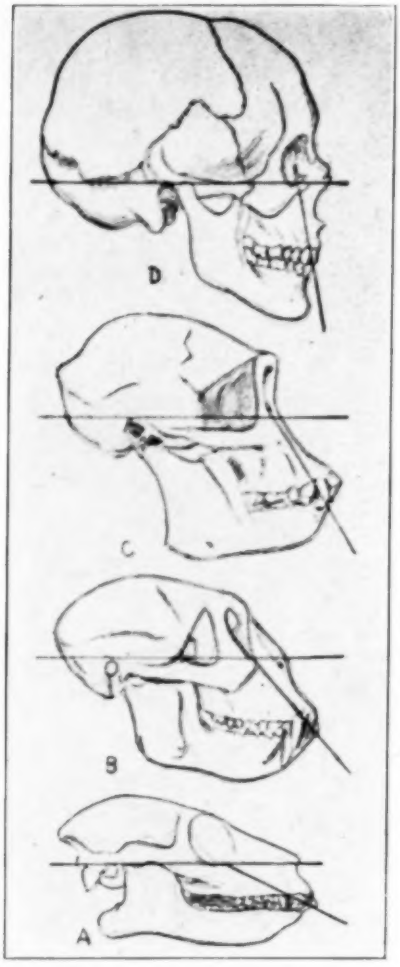


Figure 9.
Man's brain,
showing
convolutions.



Another is found in the gradual recession of the snout. It is obvious that an animal which lives in trees and is fated to descend therefrom must be able to see objects below. A protruding muzzle is an obstruction which Nature has gradually eliminated.

Figure 10. Lateral aspect of skulls of Primates, showing progressive shortening of the muzzle, downward bending of the face below the eyes and forward growth of the chin.

A. Eocene lemuroid.
B. Old World monkey.
C. Female chimpanzee.
D. Man.

(Gregory. Our Face from Fish to Man.)

Further evidence is noted in the progress of the orbits from the sides to the front, as illustrated in Fig. 11. There is some significance in the fact that this change is paralleled by a similar movement of the orbital axes in fetal life as shown in Figs. 12 and 13.

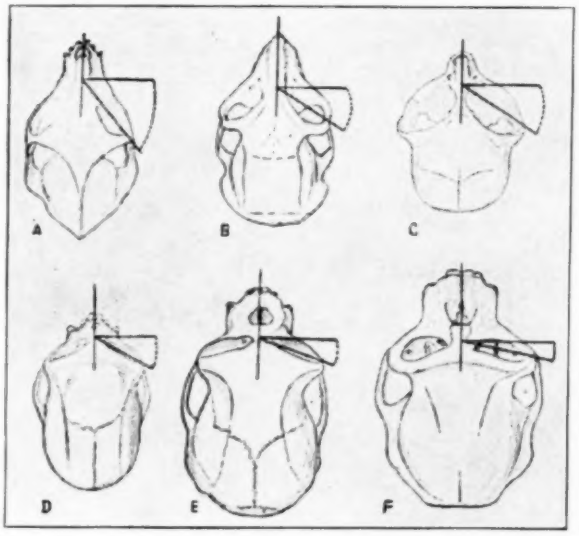


Figure 11. Superior view of skull in representatives of six families of Primates, showing more forward direction of the orbits in the higher forms.
A. Fossil lemuroid.
B. African lemur.
C. Tarsier.
D. Marmoset.
E. Gibbon.
F. Chimpanzee.
(Gregory. Our Face from Fish to Man.)

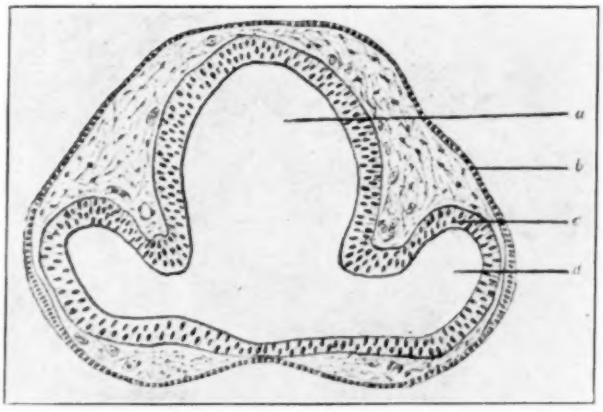


Figure 12. Transverse section through anterior part of fore-brain and optic vesicles of 4 mm. human embryo (after Seefelder). A. Cavity of forebrain. B. Surface of ectoderm. C. Wall of optic vesicle. D. Cavity of optic vesicle. (Mann. Development of Human Eye.)

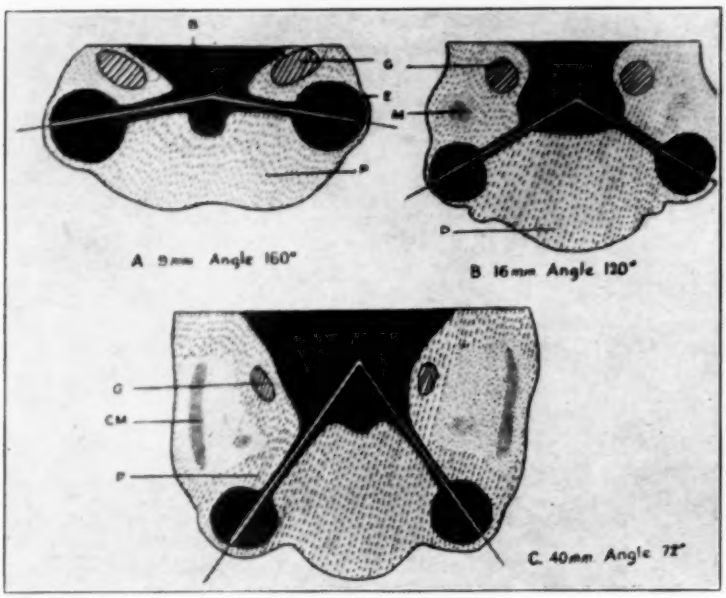


Figure 13. Schematic sections through the developing eyes and optic stalks of human embryos of various stages. A. 9 mm. embryo. B. 16 mm. embryo. C. 40 mm. embryo. The decrease in the angle between the optic axes is apparent. B. Brain. E. Eye. P. Paraxial mesoderm. M. Maxillary mesoderm. G. Gasserian ganglion. CM. Temporal condensation in maxillary mesoderm. (Mann. Development of Human Eye.)

There are also alterations in the musculature of the eyes. In the fishes' eyes both oblique muscles are attached toward the front of the orbit, thus permitting rotation of the eye forward. There are other peculiarities in fishes and lower animals, mostly with reference to attachment of muscles, which are consistent with orbital structure and ocular function.

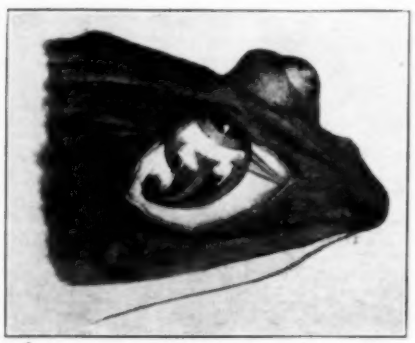


Figure 14.
Extrinsic muscles of frog.
(Stevens. Motor Apparatus of the Eyes.)

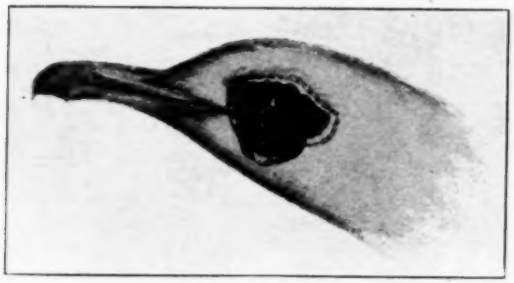


Figure 15. Extrinsic muscles of the gull. (Stevens. Motor Apparatus of the Eye.)

(To be continued in the November issue)

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THE DIOPTRIC VALUE OF THE CORNEA, PREVALENCE OF HYPEROPIA OVER MYOPIA, PERCENTAGE WITH THE RULE AND AGAINST THE RULE ASTIGMIA*

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Bridgeton, N. J.

The following report is taken from 921 private cases. The lesser of the two principle meridians in dioptric power has been assigned the Primary Meridian and it is this Primary Meridian which is used in this report to represent the dioptric power of the cornea.

It is understood that the dioptric power as designated on the Keratometer, which in this case was a Genothalmic Universal, is not the EXACT dioptric power of the cornea when used as a refractive surface for the ocular functions. This is true since the Keratometer determines the power of the cornea by reflection; whereas, the power of the cornea during the function of vision is used under refraction. However, most manufacturers have calculated, by assuming a corneal index of approximately 1.337, a fairly accurate dioptric representation of the corneal findings obtained by reflection. Thus, for all practical purposes, the dioptric value taken from the Keratometer is quite usable and approximates very closely the true dioptric power of the eye in the act of vision.

In the 921 private cases, the average dioptric power for the Primary Meridian was found to be 43.62 D. Chart 1 shows the dioptric distribution of these cases.

The average dioptric power of the Primary Meridian in the Hyperopic cases was a little lower, 43.00 D. The percentage of Hyperopic cases was found to be 77.3 per cent. Chart 2 shows the dioptric distribution in the Hyperopic cases.

Likewise, the average dioptric power of the Primary Meridian in the Myopic cases was calculated and gave a higher finding of 44.25 D.

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*Submitted for publication July 20, 1933.

[1]Instructor in Optometry at the Pennsylvania State College of Optometry.

T.O.C.
TOTAL OF ALL CASES
NUMBER OF CASES
0
10
20
30
40
50
60
70
80
90
DIOPTRES
30.00
30.25
30.50
30.75
31.00
31.25
31.50
31.75
32.00
32.25
32.50
32.75
33.00
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46.75
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48.00
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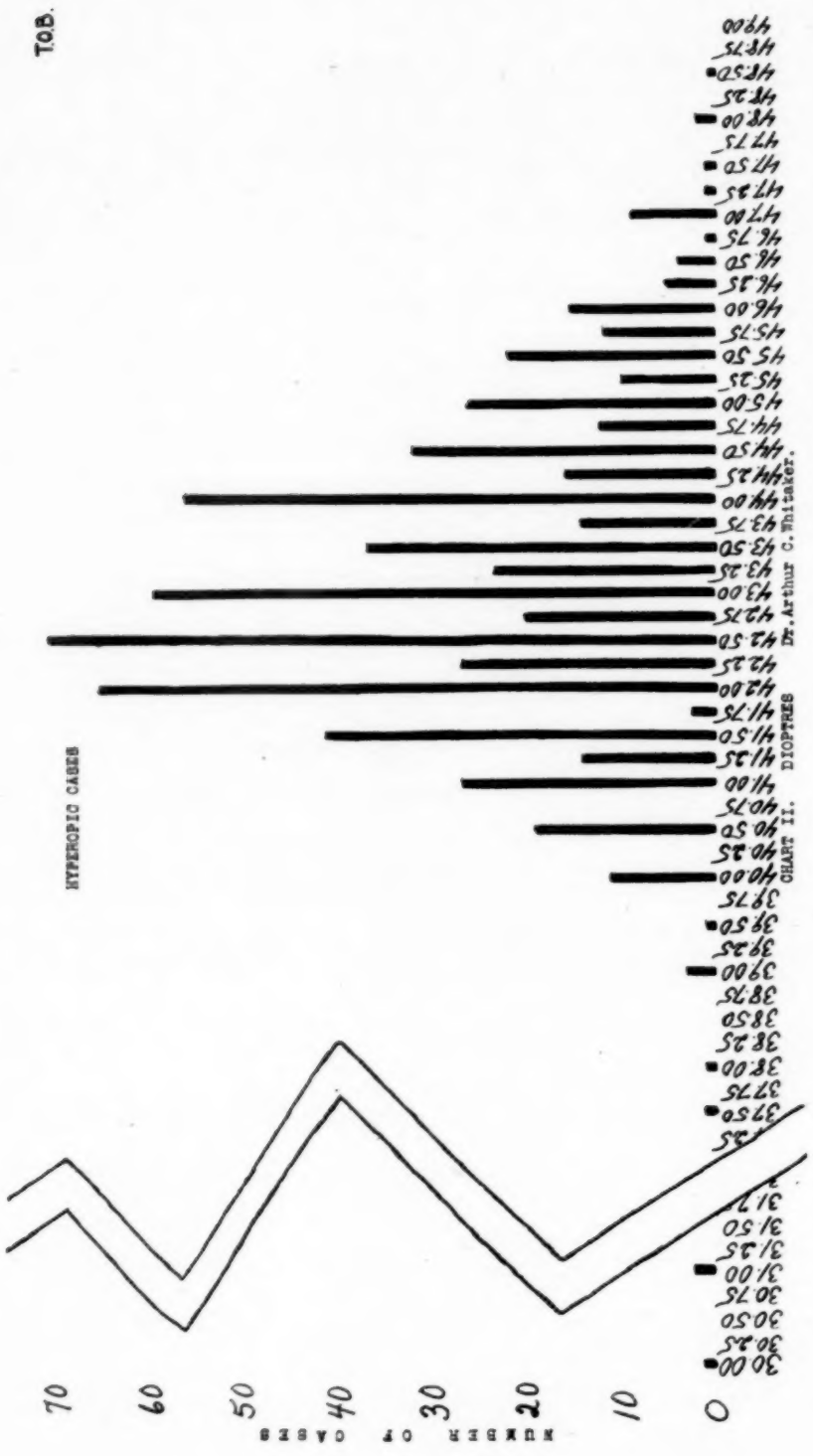
48.50
48.75
49.00
Dr Arthur C. Whitaker.
CHART I.


T.O.B.
HYPEROPIC CASES
CHART II.
DIOPTRES
Dr. Arthur C. Whitaker.
NUMBER OF CASES
0
10
20
30
40
50
60
70

The percentage of Myopic cases was 22.7 per cent. In other words, we found no True Emmetropes in the 921 cases. Chart 3 shows the dioptric distribution in the Myopic cases.

With the rule and against the rule corneal astigmia was investigated and the percentage of each was found to be as follows: with the rule, 90.6 per cent; against the rule, 9.4 per cent.

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A COMPARISON OF THE ACTUAL NEAR ABDUCTIONS WITH THE PECKHAM AND THE RYER-HOTALING EXPECTANCIES*

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In the April, 1933, issue of this journal appeared a striking article by Drs. E. LeRoy Ryer and Elmer E. Hotaling entitled, "The Relation Between Physiologic Exophoria and Near and Distance Abductions," in which were given the results of an investigation of 1,000 cases to ascertain which of two hypothesis for arriving at the near abduction expectancy checked closer to the actual measurement. The two hypotheses mentioned by the authors were (1) the expected near abduction should equal the amount of the distance abduction plus the equivalent in prism diopters of the near convergence at the point of measurement, and (2) the expected near abduction should equal the amount of the physiologic exophoria plus the distance abduction. The first hypothesis is the one advanced by Peckham, and the second by Ryer and Hotaling.

Since the latter discovered a great discrepancy between their findings and the Peckham expectancies, the writer decided to investigate 100 cases from her files, taking them without regard for age or sex, but using only those cases uncomplicated by anomalies of accommodation and in which a definite knowledge was had of the resultant comfort or discomfort. However, as a certain uniformity of data appeared, it was decided to use only 50 cases.

The distribution of ages among these cases was:

Cases from 14 years to 21 years	6
Cases from 21 years to 31 years	17
Cases from 31 years to 41 years	14
Cases from 41 years to 51 years	4
Cases from 51 years to 61 years	6
Cases from 61 years to 71 years	3

*Submitted for publication July 31, 1933.

Following is a tabulation of the writer's findings in these 50 cases:

Table I

No. of cases in which Peckham expectancy and the measured near abduction were equal	10
No. of cases in which Peckham expectancies were higher than measured near abductions	20
No. of cases in which Peckham expectancies were lower than measured near abductions	20
No. of cases in which Ryer-Hotaling expectancy and measured near abduction were equal	0
No. of cases in which Ryer-Hotaling expectancies were higher than measured near abductions	0
No. of cases in which Ryer-Hotaling expectancies were lower than measured near abductions	50

These data were further analyzed to determine the relationship between the number of prism diopters of variation and the groups of cases. Table II gives this information.

Table II

	Peckham Expectancy	Ryer-Hotaling Expectancy
No. of measured near abductions equal to	10	0
No. of measured near abductions 1△ above or below	12	0
No. of measured near abductions 2△ above or below	8	2*
No. of measured near abductions 3△ above or below	4	1
No. of measured near abductions 4△ above or below	5	4
No. of measured near abductions 5△ above or below	5	5
No. of measured near abductions 6△ above or below	4	3
No. of measured near abductions 7△ above or below	0	6
No. of measured near abductions 8△ above or below	2	3
No. of measured near abductions 9△ above or below	0	5
No. of measured near abductions 10△ above or below	0	6
No. of measured near abductions 11△ above or below	0	5
No. of measured near abductions 12△ above or below	0	4
No. of measured near abductions 13△ above or below	0	1
No. of measured near abductions 14△ above or below	0	1
No. of measured near abductions 15△ above or below	0	2
No. of measured near abductions 16△ above or below	0	1
No. of measured near abductions 18△ above or below	0	1

*All in this column were above the Ryer-Hotaling expectancy.

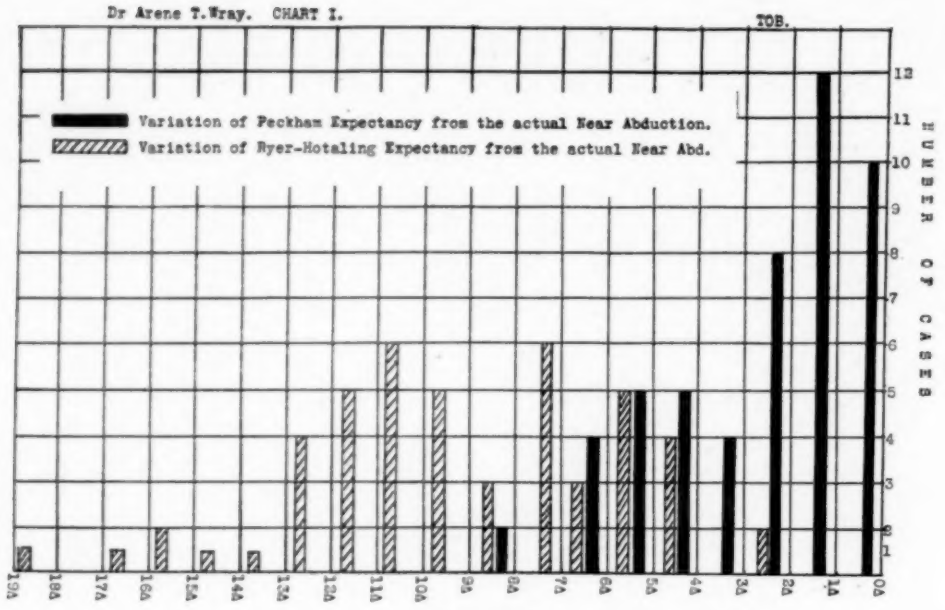

Chart I

From Table II and Chart I it will be seen that in the 50 unclassified cases investigated 20 per cent tallied exactly with the Peckham expectancy and 40 per cent varied no more than 2△. The greatest difference between the measured near abductions and the Peckham expectancy was 8△, whereas one case displayed as much as 18△ difference between the actual and the Ryer-Hotaling expectancy.

One explanation for the close correlation between the writer's findings and the Peckham expectancy may lie in the technique of measurement. The De Zeng phoropter with its Risley prisms of 30△ each is used together with the Jacques near point chart at 16″, which is a reduced Snellen chart. The patient is instructed to read the lowest line of type he can decipher and to inform the examiner when these letters are completely blurred out, at which time he is to shift his gaze to the large E at the top of the chart and watch intently for the break. The Ryer-Hotaling method of measuring ductions is one using a complementary red-green test, with the details of which the writer is not familiar. Hence it would seem that these two techniques are productive of different findings,—additional evidence for the necessity of a standardization of technique.

Of the 50 cases studied 42 reported comfort with the new prescription and among these was the case exhibiting the 18 point difference between the actual and the Ryer-Hotaling expectancy. Orthoptic training of a base out nature was given in three cases, one of which

reported comfort although the results as far as duction measurements are concerned, were negative. One of these cases was given a total of 2△ base in in her correction (single vision lenses). Four reported discomfort, which, in one case, was undoubtedly due to a systemic involvement.

The conclusions to be drawn from the foregoing would be:

(1) A consideration of distance abduction, physiologic exophoria and near abduction alone is not sufficient for prescribing orthoptic treatments.

(2) An orthodox adherence to tables of expectancies as the *sine que non* for optometric diagnosis is dangerous.

(3) The necessity for standardized technique.

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ASPECTS OF EYE PHYSIOLOGY*

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Introduction

Light is a form of energy propagated through ether with a velocity of about 186,000 miles per second. In the form of electro-magnetic waves covering a range of a little under one octave it can be seen to occupy about a mid position with reference to other wave frequencies so far discovered by man. It is an etheric wave and can be transmitted throughout all space but is subject to interruption by most forms of matter, thus although ether permeates all matter light cannot pass through more than a few types of matter. The cornea of the eye, glass and quartz, are examples of substances which allow the ether permeating them to transmit light waves.

Most gases and many liquids are also transparent, but no substance is perfectly transparent to the extent that it would not bar light waves even if it were of great depth.

As a general rule, matter can be said to absorb light energy. Such absorbed energy is usually dissipated as heat, but when we study living things we find that many of them appreciate the value of light energy and use it—this is illustrated in the plant chlorophyle system. In the plants the sun's light energy is used to build up complex foodstuffs from simple precursors, thus creating stores of potential energy. This can be regarded as one of the most fundamental phenomena in all the story of terrestrial life. It has proved a basic means of manufacturing the complex organic units of living things out of the simpler compounds and elements extant in the earth's crust.

Being a wave motion, light has both amplitude and frequency as well as wave length. To us these features mean colour and intensity. When the light waves of different frequencies are suitably compounded white light is formed, and of such nature is sunlight. Of course, the sun is not concerned only with light production. Matter, we said, absorbs light, but we know that we can see objects so it becomes apparent that

*An abridgment of the Material Presented before the Institute of Optometrists at their monthly meeting in March, 1933, in New South Wales. From the May, 1933, Australasian Journal of Optometry.

TABLE OF ELECTRO-MAGNETIC AND SOUND WAVES

	Octaves	Vibrations		
	70	15.36	Sextillions	10 million times of light; New Cosmic rays (Millikan); So hard that they penetrate 6 feet of lead
UNKNOWN	68	3.84	"	
	66	960.00	Quintillion	
RADIUM	64	240.00	"	
GAMMA	62	62.00	"	
WAVES	60	15.00	"	
	58	3912.00	Quadrillion	
	56	978.00	"	
	54	244.50	"	X Rays
	52	62.00	"	
	50	15.00	"	
	48	3.80	"	
	46	956.00	Trillion	
	Light 434		red	
		500	orange	
		530	yellow	
EYE		570	green	
		634	blue	
		690	indigo	
		740	violet	
	44	230.00	"	
	42	50.00	"	
	40	14.00	"	
	38	3.70	"	Bolometer
	36	934.00	Billion	
	34	233.00	"	
	32	58.00	"	
UNKNOWN	30	14.50	"	
	28	3.60	"	
	26	912.00	Million	
	24	228.00	"	Electrical waves
	22	57.00	"	
	20	14.00	"	
	18	3.50	"	
	16	890.00	Thousand	
RADIO	14	222.00	"	
	12	55.00	"	Limit of hearing
	10	13.00	"	
	8	3,480	Piano limit	
	6	870		
EAR	4	217	Middle C is 261	
	2	54		
	1	27		
	½	13	Lowest vibration heard	

some light must be reflected, and we are aware that most objects absorb only part of the light waves coming to them and reflect others, thus giving us a means of describing their colour. To indicate the relative position of the light waves a small table has been compounded on the previous page of different waves arranged in order of frequency, from the rapid electromagnetic waves down to the slow air waves.

From our physiological viewpoint it becomes of interest on looking at the table to find that of all these numerous and diverse waves and rays we are able to appreciate directly by our senses only two sets—about 12-13 octaves of sound waves and less than a complete octave of light waves. This is more astounding when we are given to understand that this table covers probably just a fraction of the waves traversing the universe. 70 octaves or so are familiar to physicists, but some estimate that the range of waves can be placed at not less than 300 billion octaves!

The lower frequency waves are propagated in matter such as the air, and with our ears we can appreciate vibrations varying in rate from about 13 per second to 25,000. Some animals are known to hear frequencies much higher than this, and the story is recorded of the scientific wag who made a whistle, which could blow a note of high frequency with generous amplitude, and betook himself to the Zoological Gardens on Sunday afternoons there to drive into mild frenzy the unfortunate animals who could hear the shrill insistence of his whistle. Uninitiated visitors to the gardens doubtless often wondered what caused the disquiet of the animals whenever the funny looking little man, with his hand over his mouth, came past.

Above the sound waves energy passes through the ether as a medium, and when we think of the tiny fraction of these of which nature has vouchsafed us any direct appreciation we are astounded at the amount of information this small fraction can give us. This leads us to speculate as to what, if any, different sensory equipment may be manifest in other living organisms. We will roughly steer our inquiry in this direction by briefly surveying the eye from a comparative aspect.

Comparative Aspects of Vision

The very low forms of life have no visual apparatus, but sensitivity to light is almost universal. Commencing with the plants, we find light recognition evidenced in their helio-tropisms, but whether or not they have any specialized apparatus for light reception is unknown. Plants are dependant on light for their life and growth, but probably are not interested in the revelations of light.

In this aspect even the humblest of moving organisms is different. Neglecting the bacteria and microbes we find primitive Protozoans-Protista possessed of "eye spots." These are the minute pigmented spots by means of which it is thought that the unicellular organisms such as are seen in any aquarium, are enabled to move to areas of most suitable illumination. Plemonema, a small animal somewhat like Amoeba, will contract its pseudo podia when light falls on it. In going up the scale to

the Coelentrates the only modification of the eye spot seems to be the elaboration of an optic cup-like structure heavily pigmented. In some of the worms, however, are very complex eyes. The polydraetes exhibit true camera eyes. In cephalopods the retinal structure is highly complex, having internal and external layers, while cornea, lens and ciliary body somewhat analogous with the vertebrate eye are developed.

The most fascinating eyes, however, are to be found in the Anthropods. Two main types of eyes are seen in these creatures, and some possess both types, having a double visual equipment.

The ocellus is the name given to the simpler organ, which is probably developed to enable its possessor to observe changes in light intensity —probably making it possible to notice movement as well. Numbers of the Arthropods are provided with these organs, but the more active members have developed the remarkable eye known as the compound eye, because it is really made up of numerous facets, each one a minute eye.

Avekury and Fonel have been able to show that bees and wasps, which are very active insects provided with highly developed compound eyes, can distinguish between some colours and may even be able to recognize the form of some objects.

The Compound Eye has no mechanism of accommodation so far as can be determined, and each tiny eye just accounts for its own particular part of the visual field. Perhaps different facets have different accommodation.

The Compound Eye seems to prove a curse to some of its possessors, who feel that it has no better use for them than to lead them to regions of brightest illumination. All Australians are familiar with the poor, futile, little creatures which cannot say no to the attraction of a street light, and wear themselves out in frenzied adoration at the shrine of light. An interesting feature of the night-flying insects is the rhythm with which they alternate rest and activity. It used to be thought that they rested during the illuminated daytime and with declining light started out on their flying in search of food. They have eyes with retinal structures analogous to the rods of vertebrate eyes, and can fly with a fair measure of success in the semi-dark. It has been shown, however, that even if kept in total darkness they commence flying about in their chambers as twilight comes on and remain quite dormant during the day. Apparently light is *not* the determinant for the maintenance of their rhythms, and no explanation is yet advanced.

Two common insects, the dragon-fly and the house-fly, have both ocelli and compound eyes, and cannot fly properly with varnished eyes, but are unaffected when their ocelli are varnished. Why they possess both types of organs is obscure. The May-flys are peculiar in that the male has a divided type of eye, one section "light adapted," so to speak, for day flying, and the other smaller section "dark adapted," to enable the creature to fly at night or twilight. The ability of the bees to appreciate some colours, as mentioned before, shows some very interesting

features. Experiments show that they cannot perceive red rays, but can see rays away down in the ultra-violet regions. Their visual appreciation extends over about three-quarters of an octave, much as ours does, but it has slipped down a little. Also their appreciation does not conform to ours in grouping. They cannot distinguish between green, yellow, and a bluish colour, and class all these together. Blue, violet, and indigo are grouped in another set, and the ultra-violet series forms another set. Thus three main colours seem to be recognized, but no blending is effected. Incidentally, the non-recognition of red makes one suspect that some brightly red-coloured flowers are wasting their pigments as far as bees are concerned.

Leaving the Arthropods I should mention a peculiar worm-like creature known as Peripatus, which is half-way between the worms and Arthropods. This creature has very well-developed ocelli, but hates the light and shrinks away from it, so it appears that his eyes are used merely to enable him to hide where he cannot use them. In the molluscs it is a peculiar thing to find a shellfish like spondylus, which remains fixed during life—often in quite dark places—possessing eyes of great anatomical complexity, and resembling those of the actively swimming bivalve, Pecten. Lima, another bivalve, has very crude eyes, although it swims actively.

The Vertebrates have eyes very similar throughout, but individualities appear here and there. Some reptiles possess a remarkable control over their retinal units—the rods and cones. They can withdraw the cones and push forward the rods for vision in the twilight, performing the reverse for daylight vision. This is quite unique, and seems a very useful feature. The method of accommodation varies in the different groups, and four distinct means can be enumerated:—

(i.) Altering the convexity of the corneal surface.
(ii.) Bodily movement of the lens along an antero-posterior axis.
(iii.) Alteration in the antero-posterior diameter of the eyeball.
(iv.) Alteration in convexity of lens surfaces.

Of these the last is the type seen in the higher eyes, including those of man. Great differences must exist in the types of vision among the vertebrates owing to physiological differences. For instance, some amphibians who live both on land and in water, use their eyes in both media, but proper accommodation can be effected in only one. Of such animals some show very defective vision in the air but see well in water. The reverse is the case for the common frog, who is better adapted for air vision. Colour vision is absent among nearly all vertebrates so far investigated, and only the higher types can discriminate wave-lengths. It is not known yet whether animals which see colour do so in a manner analogous to that of man. Man's colour vision is not a simple system of discrimination between waves, but shows a most peculiar ability to blend colours besides numerous other features known to most of you from experimental observations—after images—colour reversals and contrasts—and

so on. It may yet be found that animals have a different colour appreciation mechanism. A great advance in visual acuity has been vouchsafed the higher primates in the development of binocular vision which may be responsible for the stereognosis as seen in man. The development of a specialized area of the retina—the fovea centralis—has led to greatly enhanced detail appreciation, and has necessitated a most delicately balanced muscular mechanism for directing the eyes to a common focussed point.

Embryology

The eye appears very early in development—before the neural tube is properly folded over. It undergoes a peculiar reversal of aspect. First appearing on the external surface of the embryo as a mere depression, it becomes folded in with the developing central nervous system and appears inside the hollow of the primitive brain. From this position it grows out as a hollow tube to reach the lateral surface. It never reaches the surface but causes a most interesting physiological reaction on the overlying ectoderm. The ectoderm begins to thicken, then depresses, closes over and cuts off a small vesicle which is the primitive lens. This is known as Dependant Differentiation—that is, the lens depends on the optic evagination for its initiation. If the optic evagination is removed the lens fails to grow and, moreover, if it is transplanted to another region of the embryo such as the flank it will cause the surface ectoderm to cut off a typical lens. The eyes assume enormous proportions, relatively, in the early stages of development, as seen in the chick. The extraordinary value attached by nature to vision is indicated by the fact that the medullated nerve fibres from the eyes of man amount to over one million, whereas, as all the other offerents of medullated nature from the skin—bones, joints, tendons, muscles, etc.—amount to about one million two hundred thousand only.

The retina with its two layers is derived from the optic evagination which at its distal end swells and becomes pushed in to give an open cup. The lens comes to lie in the mouth of the cup. It will be clear that the main sensory part of the eye—the retina—is developed from the brain tissue and in the retina we find the nervous elements bearing close analogy to the elements in the spinal sensory units and ganglia, but the distil fibres are very short and end in the rods and cones.

Eye Reflexes

The eye reflexes fall into several groups and some are very complex, whilst even the simplest have not been fully worked out. Familiar ones are the "light reflex" and the "accommodation reflex." In the case of the latter it is interesting to note that the innervation is only parasympathetic whilst the pupil is under full automatic control with the sympathetic dilator and the parasympathetic constructor. These two reflexes are not intimately connected, as evidenced in the Argyll-Robertson pupil, but it is very probable that the pupil works in conjunction with the accommodation reflex to the extent that for near vision it partly

connects the spherical observation by cutting down the peripheral rays. The accommodation mechanism may be concerned with distance appreciation—the extent of accommodation giving some indication of the distance of the focussed object. This is further demonstrated by the fact that on a railway track a red light always appears nearer than a blue light. The explanation being that the eye is not achromatic and violet rays focus about half a millimetre in front of the red rays. The slight change in accommodation leads to the inferred difference in distance between the railway lights.

Other reflexes—perhaps partly volitional—are concerned with controlling and directing the binocular apparatus to the focussed point. Numerous reflexes associated with control of skeletal musculature in static and kinetic states are of visual nature. These become of absolute importance in cerebellar and vestibular lesions—vision provides the only possible compensatory mechanism. Rotation of the head round a transverse or antero-posterior axis results in ocular reflexes such that the eyes suffer a minimum of alteration in their normal visual fields as a result of the new posture. Normally this reflex is mediated by impulses from neck muscles and the labyrinths. The latter do not affect the rectus externus or the internus muscles, but the neck reflexes act on all eye muscles. The visual impulses are very important in man where other impulses may be unreliable. An aviator may fly upside down in a cloud and be unable to orientate himself till he can use his eyes. There is no time to further cover the ground in eye reflexes, and some of the work is still vaguely understood.

Enteroptic Phenomena

In closing, it may be interesting to account for the hazy, moving shadows that often flit across the field of vision—noticeably when the background is of uniform nature, such as the sky. It is noteworthy that these shadows cannot be focussed—they never appear in the direct line of vision, and when one moves one's eyes to try and look at them they move away. They are, in fact, the minute shadows cast on the retina by the blood vessels which run inside the eyeball on the surface of the retina. The eye shows very rapid adaptation to them, but they can always be noticed when desired. That they cannot be focussed will be obvious from their nature and position, and they never appear in the line of vision as no vessels run across the fovea centralis. Attempts have been made by physiologists to determine the rate of capillary blood flow by projecting them onto a screen and marking out points as movement occurs. The success has been no greater here, unfortuntely, than in other instances where the eye phenomena have been used to measure physiological phenomena. Psychologists have tried to use the measurement of the degree of dilatation of the pupil to afford an index of the amount of pain suffered by a subject, but so far vast success has not been claimed by such experimenters.

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THE OPHTHALMOSCOPE AS AN AID IN THE OBJECTIVE DETERMINATION OF ASTIGMATISM

Few optometists rely upon the findings of the ophthalmoscope in making an objective determination of the refractive condition of an eye. While the ophthalmoscope is regularly used for this purpose in Europe, the use of other refractive technics have, in a large measure supplanted the ophthalmoscope for this purpose here in America. In this the writer believes that perhaps we American optometrists are missing something of value in not enlarging our ophthalmoscopic technics and thereby getting greater refractive as well as diagnostic value from the use of this instrument.

To merely view the media and fundus is one thing. To develop an ophthalmoscopic technic whereby the gross error of refraction is estimated while the fundus is being examined is another. The latter, while more difficult at first, is nevertheless quite easy after the technic is mastered and frequently proves to be a valuable guide in the further study of the refractive condition of the eye under observation.

This ophthalmoscopic technic lends itself particularly well to those cases whereby the error of refraction is largely astigmatic. Minchin[1] finds

[1]Minchin, H. D. Astigmatism. Lectures delivered at the Twenty-fifth Convention of the A.O.A. Indianapolis. pp. 22-30. 1922.

that the ophthalmoscope supplies us with a series of objective signs that are reasonably dependable, and he claims further that these objective determinations are best made by use of the ophthalmoscope.

The objective signs referred to are (1) A lack of asymmetry may be discovered by the fact that the vessels proceeding from the optic disc do not show up equally. (2) Difference in shape of the optic disc. (3) The enlargement of the image will be different in the various meridians when a lack of asymmetry is present. (4) When using the erect image the fundus in the meridian of least power is seen by means of the weaker positive lens. More plus must be added to view the meridian at right angles to this. (5) The reverse of this is true when viewing the fundus with the inverted image, and (6) In making opthalmoscopic determinations of the degree of astigmatism we find the spherical lens that will correct each meridian. The difference between these two will give the amount of astigmatism present. C. C. K.

* * * * *

MIGRAINE

The ordinary description of migraine is a paroxysmal affection comprising severe unilateral headache, preceded by visual phenomena, and followed by nausea and vomiting. Any two of the important symptoms may be absent without invalidating the diagnosis of migraine. The malady without visual phenomena is fairly frequent; it is also possible to have attacks without nausea and vomiting, and even with headache in abeyance.

Critchley[1] subdivides the subject of clinical migraine into three major parts as follows: (1) The bilious type in which there is persistent vomiting; ocular disturbance is slight or absent, and headache is present but not severe. (2) The ocular type in which the main symptoms are visual. The attack begins with a series of visual experiences of a positive nature (fortification figures, zig-zags), or of a negative character (scotomata, hemianopia). These may be accompanied or followed by an illusory distortion of vision, such as the apparent movement or obliquity of objects; diplopia; megalopsia or micropsia; optical alloaesthesia. A state of ocular vertigo follows, often accompanied by pain in the head or in the eyeball. Vomiting usually does not occur. The visual symptoms persist throughout the attack, dominating the picture. Examination usually reveals some slight and uncorrected error of refraction, often heteronymous in type; full correction of these errors often leads to marked relief. (3) Cerebral type in which there is intense headache without visual or bilious accompaniments. While there are a number of possible precipitating factors, two of the outstanding are uncorrected errors of refraction and imbalances of the extra ocular muscles. In all cases of

[1]Critchley, M. Migraine. Lancet. January 21, 1933.

migraine every care must be taken to most fully relieve even very minor defects, as these at times result in this most disabling of common maladies. C. C. K.

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IMPROPER LIGHTING AND THE EYE

Lancaster has made a study of certain forms of improper lighting such as insufficient illumination, exposed light sources in the field of vision, causing glare, glare from reflection, such as shiny paper, the source of light well placed (out of sight), but too concentrated. Outdoor-glare or excessive light was not included in his research. He found, however, that the objective symptoms are hyperemia of the conjunctiva and of the eyeball, increased frequency of winking, frowning, slight blepharospasm and lachrymation. The subjective symptoms are more predominant; they include local, conjunctival; consisting of hot, dry, smarting, burning, itching sensations, attributable to the hyperemia. Local, ocular; consisting of fatigue, blur, photophobia, pain and aching of the eyeball, a sense of pressure, difficulty in keeping the eyes open. The more remote symptoms are headache and a feeling of heaviness.

Although this is beside the point, a review of the symptoms just outlined indicate clearly the need for a careful recording of each individual case history. This is an important matter which can never be safely overlooked. To return, however, to the symptoms, we find that the explanations that have been offered of these symptoms are that when the illumination is insufficient the book is held nearer, and the greater effort of accommodation required causes fatigue, hyperemia, etc. This may be a factor, but is not sufficient to explain the whole cause. Another suggestion is that in the case of exposed light the eye is stimulated by the bright light falling on the periphery of the retina to move so that the eye will fix the light—so that the light will fall on the fovea. This tendency has to be combated because the person wishes to keep his gaze fixed on the object at which he is looking. This conflict between the desire to look at a given object and a reflex impulse to look away from it at the light is deemed the cause of the symptoms. Other arguments are that artificial light contains a larger percentage of infra-red rays than daylight, and that the eye is not adapted to light of this kind. C. C. K.

* * * * *

ABSORPTION GLASSES

Most asthenopes, says Swann[1], will complain of photophobia if its presence is suggested by the examiner, and for this reason he finds it ad-

[1]L. A. Swann. Notes on Protection Glasses. The Dioptric Review. April, 1933, pages 101-106.

visable to only prescribe tinted lenses if the symptom of photophobia is volunteered by the patient of his own free will. He believes that a real photophobia is sufficiently noticeable for this to happen. He has also found that a type of absorption glass, canary yellow in color, will increase retinal definition, and is therefore of value in special corrections made up for shooting. He finds also that cases of irregular astigmatism usually derive benefit from the use of absorption corrections, as they lessen the scattering of light through irregular refraction. He suggests the use of glasses of the type similar to Soft-lite or Crooks for these cases of irregular astigmatism, and also suggests their use in all cases of disease of the anterior segment of the eye, excepting the lids. Diseases of the lids, the lens, the choroid and the retina should have their absorption corrections made up in a type of absorption glass which will not transmit the infra-red radiations. Swann suggests the use of Infrex or Uro glass for these ceses. As these are foreign made products, however, American optometrists can use Calobar glass in these cases which transmits but little of the infra-red radiations. Swann also mentions using a type of absorption glass in cases of high myopia, claiming to have had the best results with the glass which absorbs most of the infra-red radiations. This suggestion is new to the writer, who, while having prescribed many calobar corrections in cataract cases, has never followed this practice in cases of high degrees of myopia. It is therefore evident that in many cases, the use of some type of absorption correction, is of some value in increasing the efficiency of the patient and as optometrists it is our duty to use these aids to visual comfort when indicated. C. C. K.

BOOK NOTICES

THE PHYSICAL EFFECTS OF RADIANT ENERGY. By Henry Laurens, Ph.D. Published by the Chemical Catalogue Co., Inc., 330 West 42nd Street, New York, N. Y. 610 pages, 104 illustrations, cloth binding, 1933. $6.00.

This book is the result of the efforts of a group of distinguished scientists who served on a committee appointed by the American Chemical Society to gather and compile the evidence available about the physiological action of radiant energy and their biological effects from an experimental as well as from a clinical standpoint.

The first part of the book gives a clear exposition of the physics of radiant energy, the methods of measuring it as well as the special characteristics. One short chapter is devoted to the effects of radiant energy upon the eye, cataract and ocular therapy.

The effects upon metabolism is discussed at great length, five chapters being devoted to this important subject. The difference in growth and development of plant and animal organism artifically irradiated and those deprived of irradiation is clearly demonstrated.

A very extensive bibliography is given at the end of the book. This will be of great help to any reader who may be interested to survey the literature of any particular subject.

This book will prove of great value to all those interested in the physiological effects of radiant energy either from a clinical or laboratory research standpoint. J. I. K.

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SEEING AND HUMAN WELFARE. By Matthew Luckiesh. 275 pages, cloth cover. 1933.

The public in general, and optometry in particular, is greatly indebted to Dr. Luckiesh for his untiring efforts to unravel the mysteries of seeing. He has been working constantly for a number of years trying to discover the elements which enter into comfortable seeing. Through his efforts an enormous literature dealing with *vision* and *seeing* has been built up. The technical articles which appeared in different Journals are too numerous to mention. We shall only enumerate a few of his more important books such as: Light and Shadows and Their Application, Artificial Light, Visual Illusions and Their Application, Ultra Violet Radiation, Light and Work, Light and Health, Seeing, A Partnership of Lighting and Vision. In his book, "Seeing and Human Welfare," he points out very clearly the importance proper lighting plays in comfortable vision, and thus opens up an important field of study and application to optometry. In this book Dr. Luckiesh digests and systematically summarizes some of his former works. He points out that in order to give the public ocular comfort and efficient vision the proper application of known lighting principles is of paramount importance.

Some of the important subjects he discusses in this book are: Seeing in relation to production of human work; to nervous muscular tension; the science of seeing; external physiological factors; visual sense; internal psycho-physiological effects; seeing the third dimension; seeing is deceiving; human beings not dependable light-meters; visibility of objects and the four fundamental factors of recognition; eye defects of age and usage; nature's plan and man's; learning to see, at birth, at five weeks, at six months, at six years, on entering school, adulthood, advancing age; common eye defects; sight of school children; more help for old eyes; light and lighting; brightness of objects; preventable glare; quality of light; human seeing machines at work; high lights and shadows; production and ease of seeing.

The book is written in simple understandable language and will prove of great value not only to the optometrists but to the laymen as well. T. O. G.

ANNOTATIONS
AND
SOCIETY PROCEEDINGS

The American Journal of Optometry is the Official Organ of the American Academy of Optometry, as well as the Organ of the Arkansas, Delaware, Indiana, Iowa, Maine, Maryland, Michigan, Minnesota, Nebraska, North Dakota, Oklahoma, Pennsylvania, South Dakota, Vermont and West Virginia Optometric Associations.

The following gentlemen have consented to supply items of interest from their respective sections, acting in the capacity of

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A CENTURY OF OPTICAL PROGRESS

Business and professional men of Southbridge, Mass., united recently in honoring the American Optical Company upon completing a Century of Achievement on Service in the field of Optical Science and Industry. A testimonial dinner was given on behalf of the Wells Brothers, the leaders of the company and the community for over forty years.

The company officials were presented, on behalf of the community, with a large bronze plaque in lasting honor of its 100th anniversary. The plaque was received on behalf of the company by Albert W. Wells, who, after words of appreciation, announced that he and his brother acting upon a wish and with the funds provided by their father in 1911 would establish the George W. Wells Foundation in honor of the founders of the company. The fund now amounts to $250,000 and provision is made in the terms of the foundation to expand it to $500,000. The funds are to be used for worthy causes as they may arise.

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BACK COPIES WANTED

Dr. R. E. Hart, 7740 Champlain Ave., Chicago, Ill.; Dr. B. R. Vent, 517 Franklin St., Michigan City, Ind.; Dr. E. Johnson, 634 West Hancock St., Detroit, Mich., and Dr. M. Sternberg, 3054 Blaine Place, Chicago, Ill., are each anxious to secure

a copy of the March, 1932, issue. Dr. Peter Scholler, 6 Post Office Building, Hancock, Mich., would like the following back issues: Vol. 1, January and March to December inclusive; Vol. 2, May, June, July and August issues; Vol. 5, January, February and March issues; and Vol. 8, February and September issues. Also, we are in need of a January, 1930, issue for one of our office files. Persons having copies of the above journals and wishing to part with them, are urged to communicate either with the *American Journal of Optometry* or with the doctor direct.

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WESTCHESTER COUNTY SOCIETY

The Westchester County Optometric Society held its first meeting since the summer recess at the Roger Smith Hotel, White Plains, N. Y., on Thursday evening, September 28, 1933.

President Dr. Julius Feinberg, presided and outlined plans for the fall and winter program. The entertainment committee reported on the outing held in August.

Attending the meeting were Drs. Julius Feinberg, James J. Curran, Lester D. Gelula, John Herlihy, Harold V. Hutcheson, Lyn E. Kelley, Max K. Leeds, Carl B. Meyer, Stanton G. Nichols, Jacob Roth, Irving Shoobe, Stanley S. Susskind.

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INTERNATIONAL BOARD OF BOARDS

The Southern College of Optometry, located at Memphis, Tenn., is regarded as an approved school of optometry by the Committee on Optometric Education of the International Association of Boards of Examiners in Optometry. The school having functioned for only one year has asked to have its rating withheld until it has had an opportunity to more fully equip itself and until it has run for a full two years. Believing in the integrity of those conducting the school the Committee on Optometric Education has complied with the request of the school. It is the expressed purpose of the committee to aid and not hinder and to always give opportunity to those who are in earnest in bringing about sound standards of education in optometry.

Signed, Committee on Education.
Int. Assoc. of Boards of Examiners in Optometry.
Ernest Eimer, Opt.D., Chairman.

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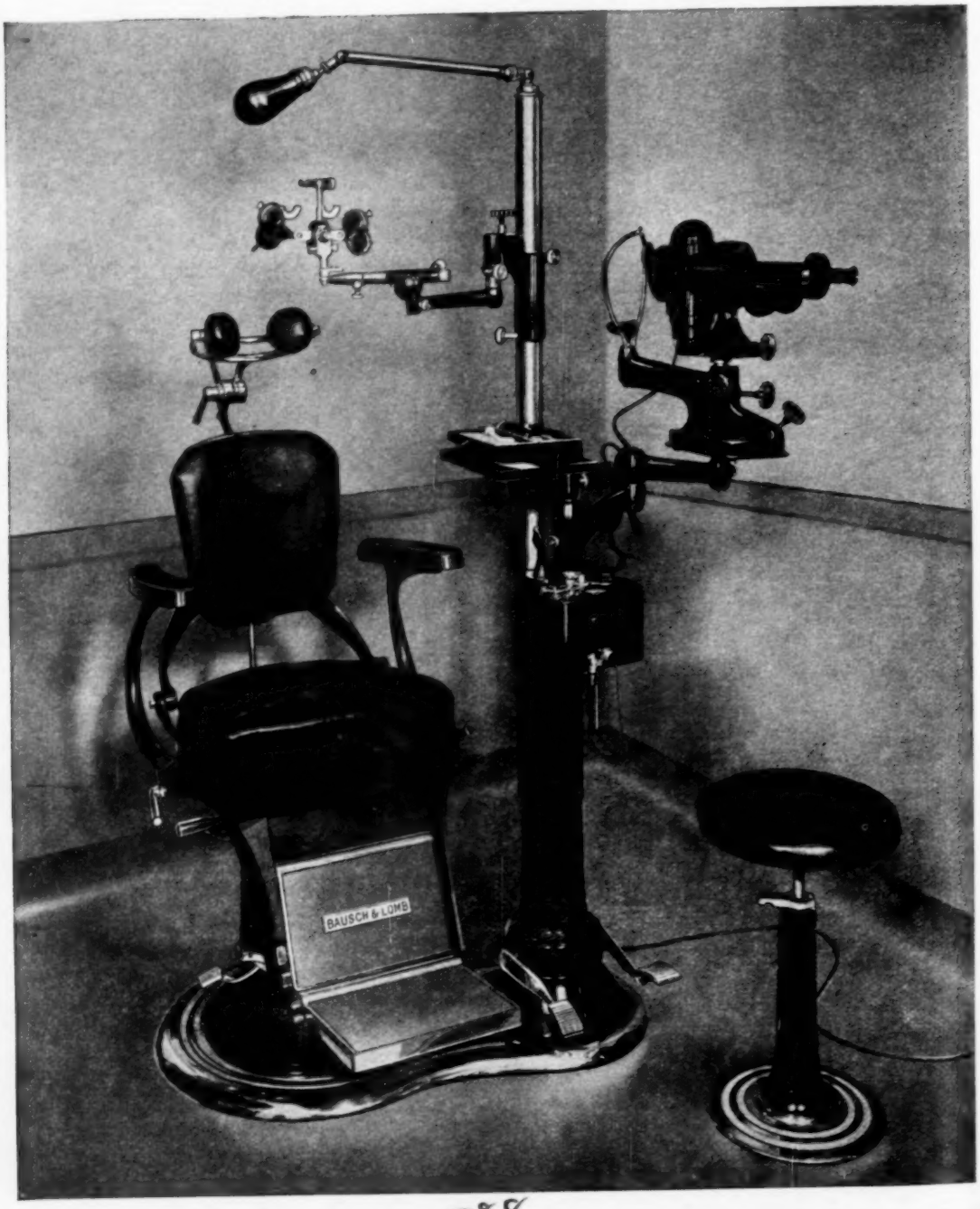

388

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